Medical
PROGRESS

Refer to: Katon RM, Bilbao MK, Rösch J: Algorithm for an aggressive diagnostic approach to obstructive jaundice (Medical Progress). West J Med 122:206-216, Mar 1975

Algorithm for an Aggressive Diagnostic Approach to Obstructive Jaundice

RONALD M. KATON, MD, MARCIA K. BILBAO, MD, *and* JOSEF RÖSCH, MD, *Portland*

GIVEN A PATIENT with obstructive jaundice, one is obliged to answer two major questions. First, is intrahepatic cholestasis present or does an extrahepatic block exist? And second, if the obstruction is extrahepatic, what is the nature, location and extent of the lesion? Historical details, physical findings and laboratory results may point to one of the many causes of intrahepatic cholestasis (see Table 1).[1-19] More often, however, symptoms and findings are not definitive and liver function tests cannot discriminate intra- from extrahepatic cholestasis (see Table 2). The diagnostic options for the clinician cover a wide spectrum. On one end is the "conservative" approach of watchful waiting, while on the other hand is the "radical" approach of diagnostic laparotomy. For several reasons, neither extreme is entirely satisfactory:

- If intrahepatic cholestasis exists, watchful waiting may delay appropriate medical therapy and worsen the prognosis. In extrahepatic cholestasis, hepatocellular damage, secondary biliary cirrhosis, gallstone fistula, deterioration of coagulation and nutrition or ascending cholangitis may ensue while the clinician charts the course of the bilirubin and enzymes. If malignant obstruction exists, the chances for resection or cure may be missed.
- Although a diagnostic laparotomy can disclose whether or not an extrahepatic block exists, there are pitfalls to this approach. Patients with primarily hepatocellular disease present a formidable operative risk and generally tolerate a surgical procedure and its attendant anesthesia poorly.

Over the past few years several authors have accepted the premise that the optimal diagnostic workup should establish or exclude extrahepatic cholestasis, and if extrahepatic cholestasis exists, the nature and extent of the process should be made known to the surgeon before laparotomy, so that he can plan the most effective operative approach.[20-24]

Physicians are now faced with a staggering list of diagnostic studies. Some are simple with little or no morbidity but offer low accuracy; other methods are complicated and expensive and present varying degrees of morbidity and even mortality. The question is which procedure or procedures should be employed and in what sequence.

We will present a brief summary of these techniques, but will stress certain of the newer ones, and conclude by suggesting an algorithm (that is, a method for problem solving, using branching logic) which we believe will allow the clinician to solve most problems of obstructive jaundice quickly, efficiently and with the maximum degree of safety.

Diagnostic Studies

Many methods have been proposed, to be employed either alone or in various combinations (see Table 3).[25-54] Each of the approaches or combinations has its advantages and disadvan-

From the Division of Gastroenterology, Department of Medicine, and Department of Radiology, University of Oregon Medical School.

Reprint requests to R. M. Katon, MD, Department of Medicine, University of Oregon Medical School, 3181 S.W. Sam Jackson Park Road, Portland, OR 97201.

TABLE 1.—*Causes of Intrahepatic Cholestasis*

Fatty Liver[1]
Viral hepatitis[2]
Alcoholic hepatitis[3]
Chronic active hepatitis; post-necrotic cirrhosis[4]
Drugs—Intravenously administered tetracycline,[5] chlorpromazine hydrochloride (Thorazine®),[6] oral contraceptives,[7] methyl testosterone,[8] halothane,[9] azathioprine[10]
Lymphoma[11]
Primary biliary cirrhosis[12]
Cholestasis of pregnancy (3rd trimester)[13]
Benign, recurrent intrahepatic cholestasis[14]
Post-operative jaundice (anoxia, transfusions, etc.)[15]
Sclerosing cholangitis[16]
Sclerosing bile duct carcinoma[17]
Dubin Johnson, Rotor syndromes[18]
Pericholangitis[19]

TABLE 2.—*Causes of Extrahepatic Obstruction*

Very common (25 to 35 percent)
Choledocholithiasis
Carcinoma, head of pancreas

Common (5 to 10 percent)
Carcinoma of common duct
Stricture, common duct
Ampullary carcinoma

Uncommon (1 to 5 percent)
Chronic pancreatitis
Sclerosing cholangitis
Lymphoma
Metastatic carcinoma
Primary liver cell carcinoma

Rare (less than 1 percent)
Post-bulbar ulcer
Hepatic artery aneurysm
Choledochal cyst
Biliary atresia
Duodenal diverticulum

TABLE 3.—*Diagnostic Approaches to Obstructive Jaundice*

Procedure
1. Liver biopsy (percutaneous, transhepatic)[25]
2. Steroid response test[26,27]
3. Hypotonic duodenography (HD)[28,29]
4. Rose Bengal liver scan (RBS)[30]
5. Intravenous cholangiography (IC)[31]
6. Drip infusion cholangiography[32-34]
7. Selective visceral angiography (SVA)[35]
8. Percutaneous transhepatic cholangiography (PTC)[36-38]
9. Transjugular cholangiography (TJC)[39]
10. Endoscopic retrograde cholangiopancreatography (ERCP)[40-43]
11. Operative cholangiography[44,45]

Diagnostic Combinations
1. Peritoneoscopy and liver biopsy[46]
2. Peritoneoscopic cholangiography[47]
3. Secretion test (ST) and duodenal cytology (DC) and HD[48]
4. Open transhepatic cholangiography (OTC) and open liver biopsy (OLB) plus omento-portography (OP)[49]
5. PTC and SVA[50,51]
6. SVA and direct portography[52]
7. PTC and RBS[53]
8. TJC and transjugular liver biopsy (TJB) and SVA[54]
9. Algorithm

tages. Percutaneous liver biopsy cannot always discriminate intra- from extrahepatic cholestasis. Even if lesions pathognomonic for an extrahepatic obstruction are noted (hepatic bile lakes, bile infarcts), the cause and site of the block remain undisclosed. Furthermore, there is a risk of bile peritonitis or hemoperitoneum in patients with high grade obstruction or associated abnormalities of coagulation or both. The clinical response to a large dose of steroids is not valid, because of too many false positives.[26,27] Hypotonic duodenography (HD)[28,29] can be helpful in pancreatic carcinoma and ampullary lesions but is not as useful in choledocholithiasis, proximal biliary tract and hepatic lesions. The separation of pancreatitis from a pancreatic neoplasm can be most difficult. The Rose Bengal (RBS) liver scan[30] may suggest extrahepatic obstruction but usually cannot determine its cause.

Intravenous cholangiography[31] often results in poor visualization in patients with liver disease. Bile ducts are opacified in fewer than 10 percent of patents whose serum bilirubin is greater than 3 mg per 100 ml. Some authors favor the drip infusion cholangiogram, claiming better visualization at higher bilirubin levels and fewer side effects.[32,33] These results are disputed by others.[34] Selective visceral angiography (SVA)[35] has advantages and will be discussed in detail. Percutaneous transhepatic cholangiography (PTC)[36-38] is diagnostic in about 90 percent of patients with extrahepatic obstruction. However, the normal (nondilated) biliary tract can only be opacified in 10 to 40 percent of cases. Its relative ease and accessibility have made it a widely used procedure. Because of the risk of bile peritonitis and hemoperitoneum, it should be done in a patient prepared for a surgical procedure.

Transjugular cholangiography (TJC)[39] and endoscopic retrograde cholangiopancreatography (ERCP)[40-43] offer several advantages over PTC although they are more difficult to do and not so widely available. These will both be discussed in some detail. Operative cholangiography[43,44]

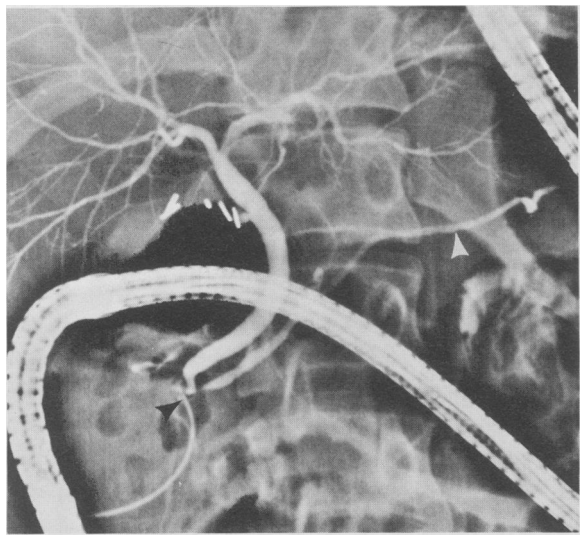

Figure 1.—Normal biliary and pancreatic ducts. Endoscopic retrograde cholangiopancreatography (ERCP) shows the side viewing endoscope in the descending duodenum, the cannula tip in the papilla of Vater (black arrow) and simultaneous filling of the biliary and pancreatic ducts. White arrow points to the main pancreatic duct in the tail of the pancreas. Surgical clips are from cholecystectomy.

Figure 2.—Biliary calculi. A hugely dilated common bile duct containing multiple calculi (black arrows) is shown with endoscopic retrograde cholangiopancreatography. White arrow points to normal pancreatic duct.

TABLE 4.—*Comparison of Cholangiographic Techniques**

	Intravenous Cholangiography	*Percutaneous Cholangiography*	*Transjugular Cholangiography*	*Transduodenal Cholangiography (ERCP)*
Difficulty	†	2†	4†	4†
Degree of Obstruction	Low (serum bilirubin less than 3 mg per 100 ml)	High only	High only	High; low; none
Ducts Visualized	Common bile duct	Common bile duct Hepatic	Common bile duct Hepatic	Common bile duct, hepatic and/or pancreatic duct
Papillary and Duodenal Biopsy and Cytology	No	No	No	Possible
Contraindication	Sensitivity to contrast	Same as for liver biopsy	Cholangitis; coagulopathy	Acute pancreatitis, hepatitis-B antigenemia†
Complications	Anaphylaxis	Bile peritonitis, hemorrhage	Sepsis, hemorrhage	Pancreatitis, sepsis

*Modified from Katon et al: Am J Dig Dis 19:303, 1974
†A relative contraindication reflecting problems in instrument sterlization.

often is diagnostic but high detail films may be difficult to obtain in the radiology department. If all cholangiograms were done in this way, the nonobstructed patients would be unnecessarily subjected to general anesthesia and its attendant risks. In terms of the diagnostic combinations, peritoneoscopy and liver biopsy[46] may document the cause of intrahepatic cholestasis and are particularly helpful in ruling in or out hepatic neoplasm. Peritoneoscopic cholangiography[47] offers the possibility of biliary tract visualization but is not generally available. The triad of secretin test (ST), duodenal cytology (DC) and HD[48] was effective in pancreatic and ampullary lesions but not as helpful in choledocholithiasis and bile duct neoplasms. The "minilaparotomy" with combined open transhepatic cholangiography (OTC), open liver biopsy (OLB) and omento-portography (OP)[49] was diagnostic in all 50 patients in one series. The absence of further reports of this com-

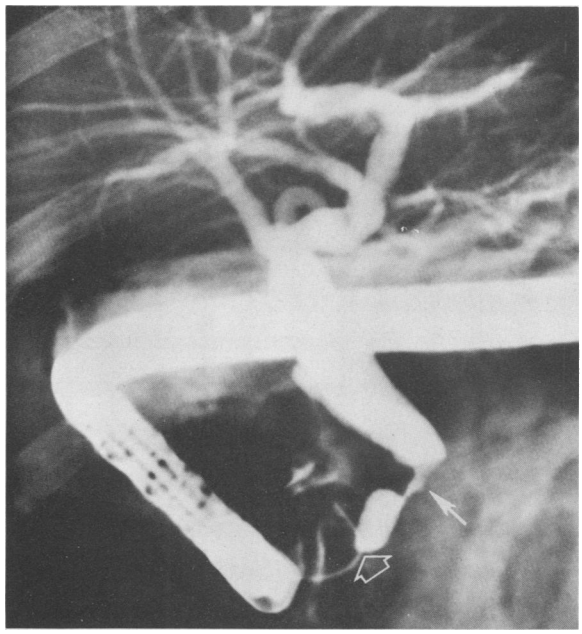

Figure 3.—Cancer of the pancreas. Endoscopic retrograde cholangiopancreatography shows the cannula in the common bile duct (open arrow). There is a short irregular narrowed segment above which the biliary tract is greatly dilated.

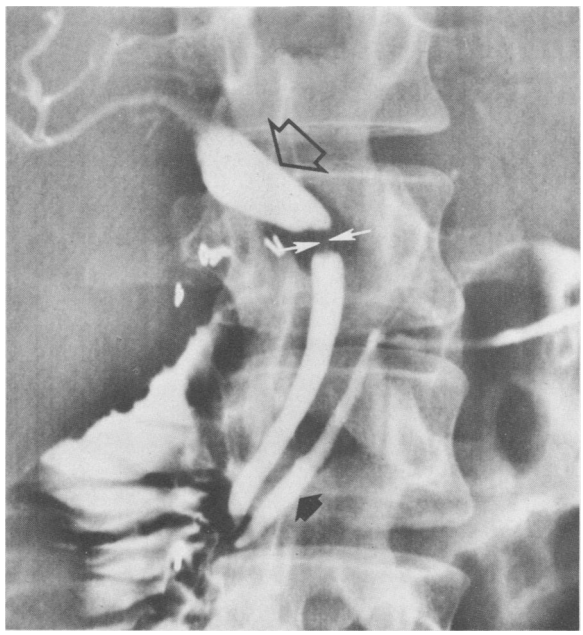

Figure 4.—Postsurgical stricture. A dilated common hepatic duct (open black arrow) above a severe stenosis (solid white arrows) is shown using endoscopic retrograde cholangiopancreatography. Normal pancreatic duct (solid black arrow). Contrast material outlines the duodenum to the left of the ducts.

bination since 1971 suggests reluctance of other centers to attempt it.

We have had extensive experience in the use of three newer procedures, ERCP, SVA and TJC, at the University of Oregon Medical School for the diagnosis of obstructive jaundice. It should be noted that these are technically demanding procedures requiring experienced personnel and delicate, costly equipment. They are time-consuming and relatively expensive for the patient. Despite these facts, the unique advantages of each allow for an aggressive but relatively safe diagnostic approach to the jaundiced patient.

Endoscopic Retrograde Cholangiopancreatography (ERCP)

ERCP refers to the placement of a lateral-viewing fiberduodenoscope into the mid-descending duodenum, cannulation of the papilla of Vater and subsequent opacification of the biliary or pancreatic ductal systems or both. While remaining a technically difficult procedure, it continues to gain in popularity and should soon be available in most medical centers. Technical aspects have been amply discussed in the literature.[40-43,55,56] ERCP is used for investigation of biliary and pancreatic diseases of various types; however, its most clear-cut indication is the investigation of patients with obstructive jaundice.

ERCP offers several advantages over other cholangiographic techniques (Table 4). First, the duodenum and papilla of Vater can be inspected under direct vision, and biopsy and brushing cytology may occasionally diagnose a pancreatic or papillary neoplasm. Second, visualization of the biliary tract does *not* depend on hepatic function as in intravenous cholangiography nor on biliary obstruction and consequent dilatation of intrahepatic ducts as in the percutaneous transhepatic or transjugular approach. Excellent biliary opacification can be obtained in the normal (Figure 1) or partially obstructed biliary tract, as well as in cases with pronounced obstruction (Figures 2, 3, 4). Third, a retrograde pancreatogram is often obtained, and may give additional clues as to the nature or cause of obstruction such as chronic pancreatitis or carcinoma of the head of the pancreas. Fourth, and probably most important, neither the peritoneum nor the liver capsule is punctured, eliminating the risks of bile peritonitis and hemoperitoneum, as in the percutaneous transhepatic route. Finally, ERCP allows the collection of cytological[57] specimens or fluid for carcinoembryonic antigen[58] study from both ducts.

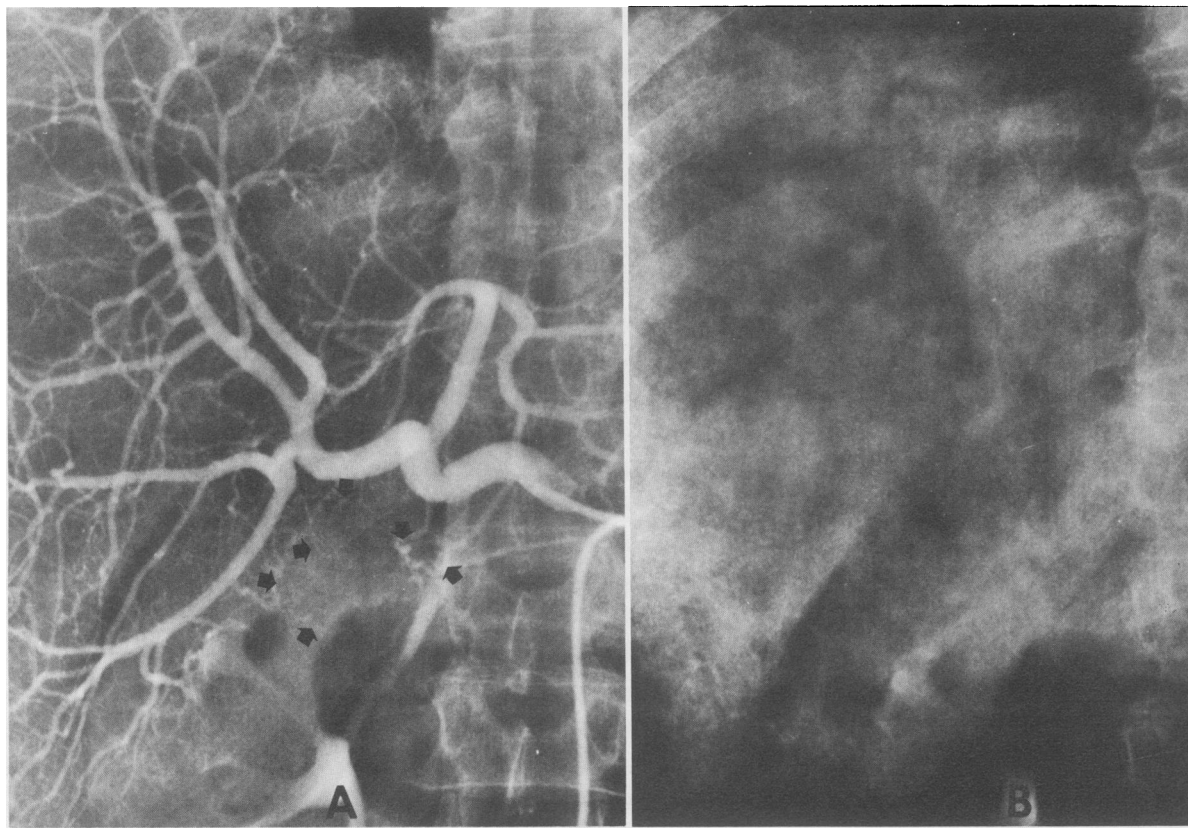

Figure 5.—Carcinoma of the hepatic duct. A, arterial phase of the selective hepatic arteriogram shows tumor invasion of small arteries in hepatic hilum (arrows). B, parenchymal phase of the selective hepatic arteriogram shows irregular ribbon-shaped translucencies throughout the liver.

ERCP does have diagnostic limitations and, at best, has been diagnostic in only 70 to 83 percent[40-43] of jaundiced patients. Failure may be due to inability to locate the papilla (3 to 5 percent), but more often it is due to opacification only of a pancreatic duct without biliary filling (20 to 25 percent). Complications may occur with ERCP, most commonly cholangitis and pancreatitis. In four large series[41-43] of ERCP in jaundiced patients plus 68 patients in our present series there were 28 complications (6.4 percent) in 436 patients. Half of these were listed as cholangitis with sepsis, and all appeared in the first 24 to 48 hours after cannulation and only in patients with extrahepatic obstruction. Other complications included fever (6), pancreatitis (3) and aspiration pneumonia (2). There was no mortality in this series of patients, although Ammon has reported fatal necrotizing pancreatitis after filling a pancreatic pseudocyst.[59]

It is prudent to advise a broad spectrum antibiotic, such as ampicillin prophylactically 24 hours before and after cannulation in jaundiced patients. If choledocholithiasis or other benign obstructive disease is documented, decompression operation within 24 hours is advisable. A probable exception to this rule is obstruction secondary to chronic pancreatitis, which may lessen as pancreatic inflammation subsides. On the other hand, if neoplasm is strongly suspected, further investigation is indicated (see Figure 10), but antibiotic coverage should be continued until biliary decompression is accomplished.

Due to its diagnostic advantages and relative safety, we prefer ERCP as the primary diagnostic procedure in patients with high-grade jaundice of uncertain cause.

Selective Visceral Angiography (SVA)

SVA can provide detailed information about individual organs and systems and is of great value in the diagnosis of obstructive jaundice.[20,51,60] By revealing the size, intrinsic vasculature and changes in the liver, pancreas, gallbladder, portal circulation and intrahepatic bile ducts, SVA helps to differentiate extrahepatic from intrahepatic jaundice,

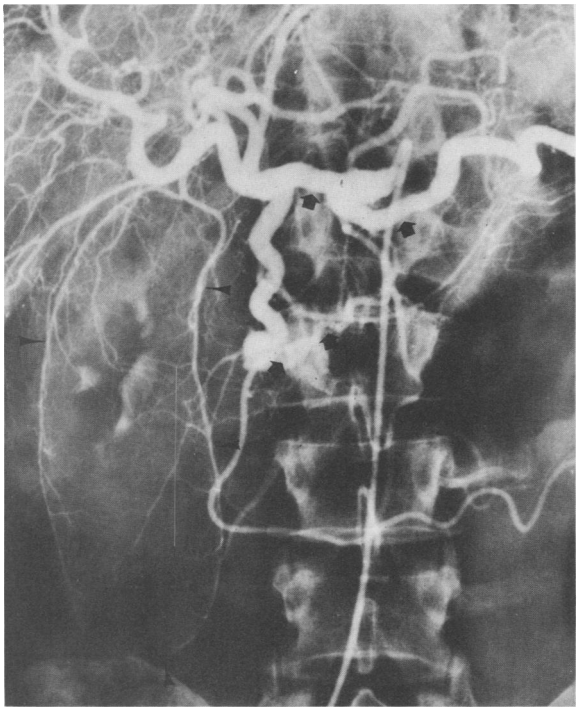

Figure 6.—Carcinoma of the head of the pancreas. Selective celiac arteriogram reveals irregularity and narrowing of the celiac, hepatic, splenic and pancreatic arteries (arrows) and enlarged gallbladder delineated by optic artery branches (arrowheads).

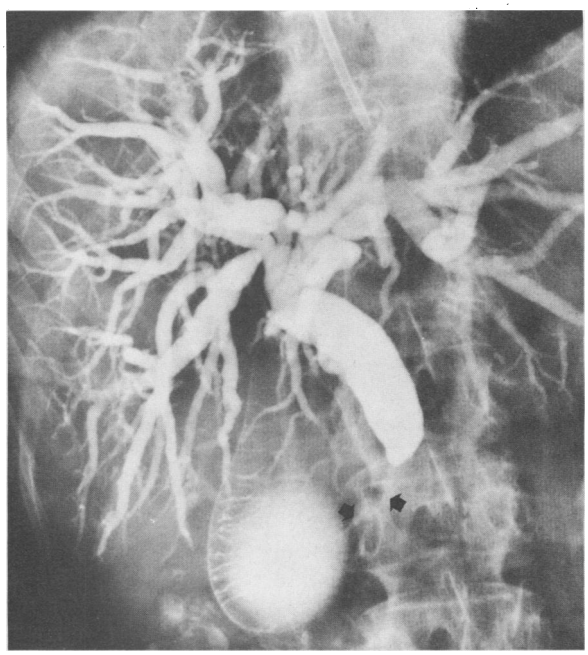

Figure 7.—Carcinoma of the head of the pancreas. Transjugular cholangiogram shows severe stenosis of the distal common bile duct (arrows) with enlargement of the biliary system.

localized from diffuse processes and non-neoplastic lesions from tumors. By determining the extent of a tumor and the secondary involvement of surrounding organs and vessels, it contributes to evaluation of tumor operability (see Figures 5, 6, 8). SVA also allows for determining the probability of successful transjugular cholangiography by indicating the size of intrahepatic ducts on the capilliary-venous hepatogram. It increases the safety of TJC by showing anatomy of liver, position of gallbladder and hypervascular structures as tumors or aneurysms, or as fluid-filled masses such as cysts or abcesses.

SVA is a relatively low-risk procedure. Local complication at the site of catheter introduction may occur, but we have experienced occlusion of the femoral artery requiring thrombectomy in less than 0.3 percent of patients.[60] Selective angiography of the celiac and superior mesenteric arteries is a standard examination. Direct hepatic artery injection provides better visualization of the liver and gallbladder. For detailed evaluation of the pancreas, direct injections into the gastroduodenal, inferior pancreaticoduodenal or dorsal pancreatic arteries give the best result.[61]

Obstructive jaundice with cholestasis and enlarged intrahepatic ducts, whatever its cause, exhibits a typical pattern on the hepatic angiogram. The intrahepatic arteries, particularly the middle-sized branches, and the liver parenchyma reveal irregular, ribbon-shaped translucencies corresponding to enlarged hepatic ducts (see Figure 5).[62] The gallbladder is best visualized in the capillary phase of angiography and its size is a helpful indicator of the site of obstruction (see Figure 6).

The diagnostic accuracy of SVA depends on the type of pathology. It is high (90 to 96 percent) in diffuse hepatic disease such as hepatitis and cirrhosis, intrahepatic tumors, particularly hepatomas and vascular metastases, and pancreatic carcinomas (see Figures 6, 8).[63-68] Biliary carcinomas, particularly those of extrahepatic ducts and the duodenal papilla, cause vascular changes relatively late when they invade the neighboring vessels (see Figure 5).[69] In the early stage, they often present only by the nonspecific enlargement of the biliary system. A chronically inflamed, enlarged common bile duct, particularly due to impacted stones, may also show typical angiographic changes. Table 5 reviews the angiographic findings in many of the lesions associated with obstructive jaundice.

Due to its wide range of diagnostic information

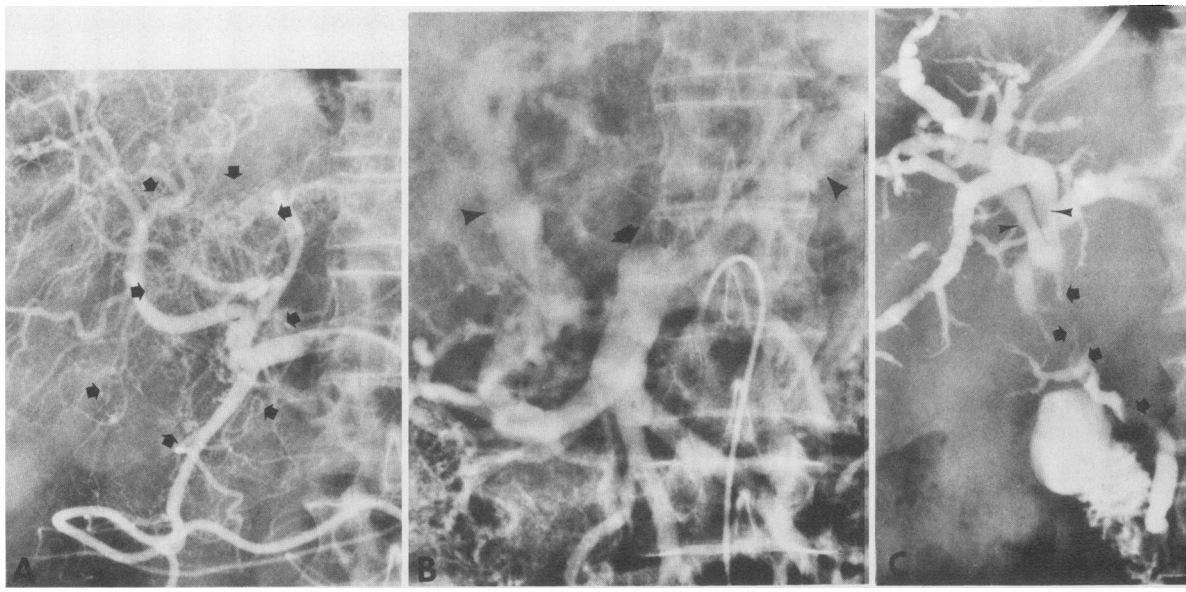

Figure 8.—Liver carcinoma extending into the porta hepatic. **A,** selective hepatic arteriogram reveals extensive tumor vascularity in the central part of the liver and subhepatic area (arrows). **B,** venous phase of the superior mesenteric arteriogram shows occlusion of the portal vein (arrow) and filling of enlarged hepatopetal and hepatofugal collaterals (arrowheads). **C,** transjugular cholangiogram reveals tight irregular stenosis of the common bile duct and hepatic duct (arrows) and displacement and narrowing of the central portion of the intrahepatic ducts (arrowheads).

TABLE 5.—*Scheme of Typical Angiographic Findings of Diseases Causing Obstructive Jaundice*

Disease	*Main Angio Findings*
Acute and subacute hepatitis	Increased hepatic vascularity and irregular outlines of smaller arteries; dense capillary phase with small hypervascular foci
Chronic hepatitis	Narrowing and stretching of medium-sized hepatic arteries, poor filling of peripheral branches, homogeneous capillary phase
Cirrhosis	Enlargement of hepatic artery and its major intrahepatic branches, cork-screwing of medium-sized branches, poor filling of peripheral branches, hypervascular foci in capillary phase with regeneration, signs of portal hypertension, collateral circulation, varices
Hepatoma	Hypervascular mass with bizarre tumor vessels, vascular lakes, and arteriovenous shunts, displacement and invasion of surrounding hepatic arteries, invasion and occlusion of portal vein branches
Hypervascular liver metastases (kidney, islet-cell, colon, breast, carcinoid carcinoma)	Multifocal tumor neovascularity, displacement of surrounding hepatic branches, multiple dense foci in capillary phase
Hypovascular liver metastases (lung, esophagus, stomach, pancreas carcinoma)	Deformity, displacement, invasion and occlusion of hepatic branches, multiple rounded defects in capillary phase
Pancreatic carcinoma	Tumor invasion and occlusion of pancreatic and peripancreatic arteries and portal vein and its branches, enlargement of gallbladder and intrahepatic ducts
Ampullary carcinoma	Enlargement of gallbladder and intrahepatic ducts (early finding), invasion of duodenal and pancreatic arteries (later finding)
Gallbladder carcinoma	Mild tumor neovascularity, invasion and occlusion of cystic artery branches (early finding), invasion of neighboring hepatic arteries (late finding)
Bile duct carcinoma	Enlargement of intrahepatic bile ducts and occasionally of gallbladder (early finding), tumor invasion of surrounding arteries (late finding)
Bile duct stones	Enlargement of intrahepatic ducts and occasionally of gallbladder (early finding), hypervascularity of the common bile duct with chronic inflammation.

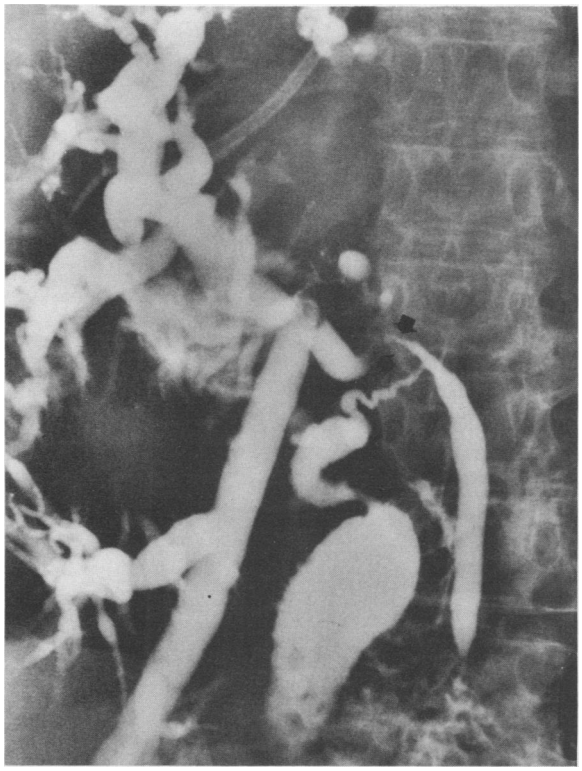

Figure 9.—Carcinoma of the hepatic duct. Transjugular cholangiogram shows tight irregular stenosis of the hepatic duct (arrows), enlargement of intrahepatic ducts and normal-sized gallbladder, cystic and common bile ducts.

and low risk, SVA is done in patients in whom ERCP is nondiagnostic or shows changes consistent with tumor to demonstrate its extent and evaluate its operability.

Transjugular Cholangiography (TJC) and Liver Biospy (TJB)

In the transjugular approach to transhepatic cholangiography and liver biopsy, a catheter needle system is introduced into the internal jugular vein and advanced down through the right atrium into an hepatic vein. The needle is then used to enter and inject the intrahepatic biliary system and to aspirate a liver specimen for biopsy (see Figures 7 through 9).[39,54,70] Safety is one of the important advantages of this approach over the standard transperitoneal technique. By eliminating the necessity for traversing the peritoneal cavity and puncturing the liver capsule, there is virtually no risk of hemoperitoneum and both procedures can be done safely, even in patients with hemocoagulation defects. Bile peritonitis is also avoided so there is no need for surgeons to stand by for possible immediate operation. In the published series none of these complications occurred.[39,54,70] Occasional occurrence of fever and sepsis after cholangiography reported in Hanafee's initial experience[70] has been reduced with the prophylactic use of antibiotics,[39] and we have not observed either.[54] TJC, however, is contraindicated in patients with acute suppurative cholangitis.

The success rate of TJC is related to the dilatation of intrahepatic ducts and ranges between 88 and 93 percent when intrahepatic ducts are enlarged.[39,54] The transjugular approach allows several safe puncture attempts from different hepatic veins and in different directions; thus the inability to enter the biliary tract is strong evidence against its dilatation. The success rate of liver biopsy in our series is 89 percent, and most failures were caused by not obtaining an adequate specimen from a hard cirrhotic liver.[54]

Performance of concurrent studies is another advantage of the transjugular approach. The recording of wedged hepatic vein pressure gives information about portal pressure, and the performance of free and wedged hepatic venography helps in detailed evaluation of liver pathology and the flow pattern of the portal circulation.[71]

We reserve TJC for patients in whom the biliary system cannot be visualized by ERCP. TJB is done occasionally in combination with TJC or as the principal goal in patients with diffuse liver disease but with coagulation defects, ascites or other contraindications to the percutaneous transhepatic approach.

Discussion: Algorithm

Over the last three years more than 100 patients with obstructive jaundice have been evaluated at the University of Oregon Medical School. This clinical experience, coupled with use of newer diagnostic techniques, permits a systematic approach to an individual patient. The algorithm (Figure 10) seems particularly well suited to this clinical situation. Given a patient with jaundice of the obstructive variety, the first question should be, Is this an acute surgical emergency? In the event of high, relapsing spiking fevers, pronounced leukocytosis and pronounced hepatic tenderness, the patient may be in overt or impending shock secondary to Gram-negative bacteremia. In this situation, with severe ascending and possibly suppurative cholangitis, the only course of action should be immediate surgical decompression after

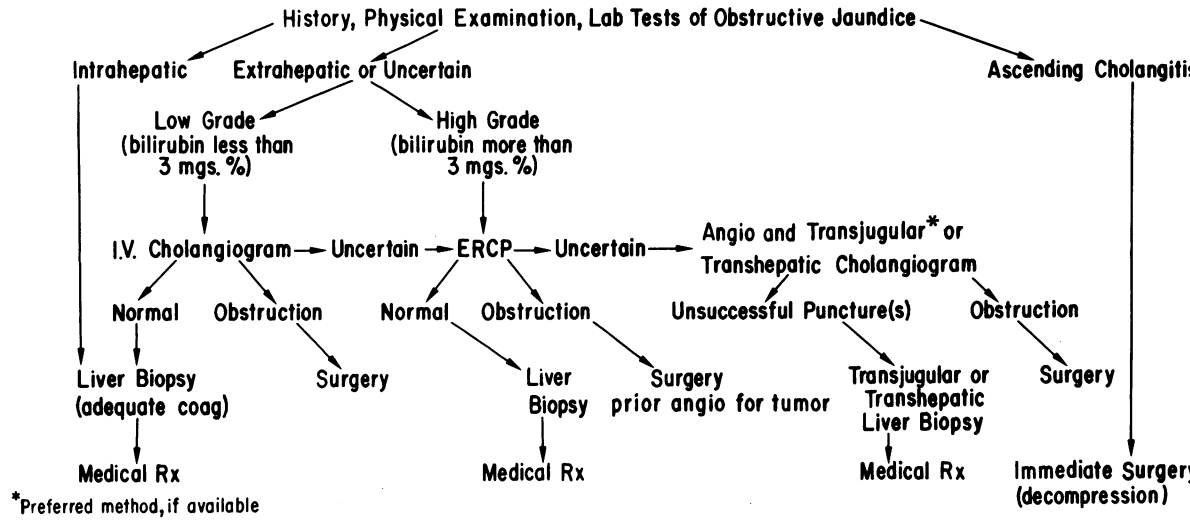

Figure 10.—Algorithm for an aggressive diagnostic study of obstructive jaundice.

stabilizing the patient with expansion of plasma volume and administering antibiotics.

The other end of the spectrum is a patient who clearly has intrahepatic cholestasis, such as an alcoholic with the signs and symptoms of acute alcoholic hepatitis, a patient with viral hepatitis and a positive hepatitis-associated antigen who has prolonged cholestatic features or a patient with drug-induced cholestasis with fever and eosinophilia. In these patients, biopsy can usually be done safely regardless of the level of the bilirubin because extrahepatic obstruction clearly is not present and they are not at risk for development of bile peritonitis. In the event of ascites or inadequate coagulation the transjugular route to liver biopsy has been used.

However, after initial evaluation, in many patients there is obstructive jaundice of uncertain origin or there clearly seems to be extrahepatic obstruction. The main concern is to visualize the biliary tract. If the jaundice is of low grade intensity (bilirubin less than 3 mg per 100 ml), we usually begin with the intravenous cholangiogram (IC). If the findings from this are clearly normal, a liver biopsy usually is done and the appropriate medical therapy may be instituted. On the other hand, if choledocholithiasis is diagnosed on IC, surgical operation should be done without delay. If the diagnosis remains uncertain after the IC or if the patient has high-grade biliary obstruction (bilirubin greater than 3 mg per 100 ml), then we proceed directly to ERCP. In our institution this has been successful 75 percent of the time regardless of whether the ducts are dilated or nondilated. Because of the relatively low complication rate and the ability to visualize a nonobstructed biliary tract, this is the procedure of choice in these patients. If the biliary tract is normal at ERCP, then a liver biopsy is done. If obstruction is due to calculus or benign stricture, surgical operation should be undertaken within 24 hours. However, when a neoplastic obstruction is strongly suggested by the ERCP, we obtain SVA before operation. This gives additional information such as the full extent of the lesion, the presence or absence of hepatic metastases and the vascular anatomy of the pancreas and liver.

If the diagnosis remains uncertain after ERCP, as it does in approximately 25 percent of the patients, then the combination of visceral angiography and transjugular cholangiography is employed. Visceral angiography provides information on hepatic enlargement, metastases, bile duct dilatation and pancreatic vascular supply which allows for discrimination between pancreatic inflammation and carcinoma. The transjugular cholangiogram follows (under antibiotic coverage), and the diagnosis and location of the extrahepatic obstruction usually (88 to 93 percent of cases), becomes obvious. The patient is then referred for surgical operation to be done within 24 to 48 hours.

If transjugular cholangiography is unsuccessful, the radiologist usually proceeds with a transjugular liver biopsy, accomplished at the same sitting. The transjugular cholangiography and transjugular liver biopsy—which are available only at a limited number of institutions—may be replaced, but with higher risk, by percutaneous transhepatic cholangiography or transhepatic liver biopsy or both.

In the case of suspected primary biliary cirrhosis, is the finding of a positive antimitochondrial antibody enough to establish a diagnosis? Since extrahepatic obstruction can be associated with a positive antimitochondrial antibody (3 to 7 percent) and since results of a liver biopsy in primary biliary cirrhosis may not be definitive, the biliary tract should be visualized before being satisfied with this diagnosis.

The use of these newer invasive but relatively safe procedures has enabled us to employ an aggressive approach in the diagnosis of obstructive jaundice. In most cases an accurate diagnosis is arrived at in three or four hospital days. Appropriate medical or surgical therapy can then be initiated without delay. Needless surgical operation in intrahepatic cholestasis is prevented, and when an operation is done it is almost always with full knowledge of the nature and extent of the extrahepatic lesion. This algorithm is not meant to be the definitive workup for all institutions nor will it necessarily remain static at our institution. As newer techniques emerge and modifications of existing ones are introduced, the algorithm will be modified.

REFERENCES

1. Ballard H, Bernstein M, Farrar JT: Fatty liver presenting as obstructive jaundice. Am J Med 30:196-201, 1961

2. Shaldon S, Sherlock S: Virus hepatitis with features of prolonged bile retention. Br Med J 2:734-738, 1957

3. Beckett AG, Livingstone AV, Hill KR: Acute alcoholic hepatitis. Med J 2:1113-1119, 1961

4. Datta DV, Sherlock S, Scheuer PJ: Post-necrotic cirrhosis with features of cholestasis. Gut 4:223-230, 1963

5. Schultz JC, Adamson JS Jr, et al: Fatal liver disease after intravenous administration of tetracycline in high dosage. N Engl J Med 269:999-1004, 1963

6. Ishak KG, Grey NS: Hepatic injury associated with the phenothiozines. Arch Path 93:283-304, 1972

7. Fawcett JW, Pederson DL: Oral contraceptives and liver damage. Br Med J 2:755, 1964

8. Werner SC, Hanger FM, Kritzler RA: Jaundice during methyl testosterone therapy. Am J Med 8:325-331, 1950

9. Sherlock S: Halothane hepatitis—Progress report. Gut 12: 324-329, 1971

10. Zarday Z, Verth FJ, Gliedman ML, et al: Irreversible liver damage after azathioprine. JAMA 226:690-691, 1972

11. Juniper K Jr: Prolonged severe obstructive jaundice in Hodgkin's disease. Gastroenterology 44:199-204, 1963

12. Rubin E. Schaffner F, Popper H: Primary biliary cirrhosis —Chronic nonsuppurative obstructive cholangitis. Am J Path 46: 387-407, 1965

13. Svanborg A, Ohlsson S: Recurrent jaundice of pregnancy— A clinical study of twenty-two cases. Am J Med 27:40-49, 1959

14. Summerskill WHJ: The syndrome of benign recurrent cholestasis. Am J Med 38:298-305, 1965

15. Schmid M, Hefti ML, Gattiker R, et al: Benign postoperative intrahepatic cholestasis. N Engl J Med 272:545-550, 1965

16. Smith MP, Loe RH: Sclerosing cholangitis—Review of recent case reports and associated diseases and four new cases. Am J Surg 110:239-246, 1965

17. Altemeier WA, Gall EA, Culbertson WR, et al: Sclerosing carcinoma of the intrahepatic (hilar) bile ducts. Surgery 60:191-200, 1966

18. Billing BH, Williams R, Richards TG: Defects in hepatic transport of bilirubin in congenital hyperbilirubinemia—An analysis of plasma bilirubin disappearance curves. Clin Sci 27: 245-257, 1964

19. Eade MN: Liver disease in ulcerative colitis. Ann Intern Med 72:475-487, 1970

20. Young WB: Obstructive jaundice—The radiologist, the surgeon and the patient (Caldwell lecture). Am J Roent Rad Ther Nucl Med 119:4-39, Sep 1973

21. Stern RB, Knill-Jones RP, Williams R: Pitfalls in the diagnosis of jaundice due to carcinoma of the pancreas or biliary tree. Br Med J 1:533-534, 1973

22. Clarke JS, Barret P, Fonkalsrud EW, et al: Diagnosis of obstructive jaundice—UCLA Interdepartmental Conference. Calif Med 112:44-58, May 1970

23. Bolt RJ: Differentiation of extrahepatic and intrahepatic obstructive jaundice (Editorial). Arizona Med 27:70-71, May 1970

24. Beal JM: Diagnosis of obstructive jaundice. Arch Surg 96: 863-868, 1968

25. Gall EA, Dobrogorski O: Hepatic alterations in obstructive jaundice. Am J Clin Path 41:126-139, 1964

26. Wruble LD, Kalser MH, Jones RH, et al: Jaundice—Value of five-day steroid test in differential diagnosis. JAMA 195:184-188, 1966

27. Chalmers TC, Gill RJ, Jernigan TP, et al: Evaluation of a four-day ACTH test in the differential diagnosis of jaundice. Gastroenterology 30:894-899, 1956

28. Bilbao MK, Frische LH, Dotter LT, et al: Hypotonic duodenography. Radiology 89:438-443, 1967

29. Bree RL, Flynn RE: Hypotonic duodenography in the evaluation of choledocholithiasis and obstructive jaundice. Am J Roent Rad Ther Nucl Med 116:309-319, 1972

30. Eyler WR, DuSoult LA, Poznanski AK, et al: Isotope scanning in the evaluation of the jaundiced patient. Rad Clin N Am 4, #3:589-603, 1966

31. Wise RE: Current concepts of intravenous cholangiography. Rad Clin N Am 4, #3:521-523, 1966

32. Cooperman LR, Rossiter SB, Reimer GW, et al: Infusion cholangiography—Thirteen years experience with 1,600 cases. Am J Roent Rad Ther Nucl Med 104:880-883, 1968

33. Bornhurst RA, Hertzman ER, McAfee JG: Double-dose drip infusion cholangiography—An analysis of 107 consecutive cases. JAMA 206:1489-1494, 1968

34. Foy RE: Slow-infusion compared with direct injection cholangiography. Radiology 90:576-578, 1968

35. Redman HC, Reuter SR: The angiographic evaluation of gallbladder dilatation. Radiology 97:367-370, 1970

36. Hines C Jr, Ferrante WA, Davis WD Jr, et al: Percutaneous transhepatic cholangiography—Experience with 102 procedures. Am J Dig Dis 17:868-874, 1972

37. Herba MJ, Kiss J: Percutaneous transhepatic cholangiography—Experience with 106 examinations. J Can Assoc Radiology 22:22-29, 1971

38. Thorbjornarson B: Anatomical diagnosis of jaundice by percutaneous cholangiography and its influence on treatment. Surgery 61:347-354, 1967

39. Weiner M, Hanafee WN: A review of transjugular cholangiography. Radiol Clin N Am 8:53-67, 1970

40. Katon RM, Lee TG, Parent JA, et al: Endoscopic retrograde cholangiopancreatography (ERCP)—Experience with 100 cases. Am J Dig Dis 19:295-306, 1974

41. Dickenson PB, Belsito AA: Duodenoscopy and retrograde cholangiopancreatography—A new method for diagnosis of obstructive jaundice. Minn Med 56:859-862, 1973

42. Blumgart LN, Cotton PB, Burwood R, et al: Endoscopy and retrograde choledochopancreatography in the diagnosis of the jaundiced patient. Lancet 2:1269-1273, 1972

43. Vennes JA, Silvis SE: Endoscopic visualization of bile and pancreatic ducts. Gastrointest Endosc 18:149-152, 1972

44. Acosta JM, Gatheringham WT, Ruiz LO: Operative cholangiography. Arch Surg 99:29-32, 1969

45. Grace RH, Peckar VG: The value of operative cholangiography using an image intensifier and a television monitor. Br J Surg 55:933-938, 1968

46. Mosenthal WT: Peritoneoscopy, a neglected aid in the diagnosis of general medical and surgical disease. Am J Surg 123:421-428, 1972

47. Keil PG, Landis SN: Peritoneoscopic cholangiography. Arch Intern Med 88:36-41, 1951

48. Bourke JB, Swann JC, Brown CL, et al: Endocrine pancreatic function studies, duodenal cytology and hypotonic duodenography in the diagnosis of surgical jaundice. Lancet 1:605-608, 1972

49. Strack RP, Newman HK, Lerner AG, et al: An integrated procedure for the rapid diagnosis of biliary obstruction, portal hypertension and liver disease of uncertain etiology. N Engl J Med 285:1225-1231, 1971

50. Gothlin J, Monsoor M, Tronberg KG: Combined percutaneous transhepatic cholangiography (PTC) and selective visceral angiography (SVA) in obstructive jaundice. Am J Roent Rad Ther Nucl Med 117:419-425, 1973

51. Boijsen E, Reuter SR: Combined percutaneous transhepatic cholangiography and angiography in the evaluation of obstructive jaundice. Am J Rad Ther Nucl Med 99:153-161, 1967

52. Aransen KF, Lunderquist A, Nylander G: The comparison of celiography and direct portography in the diagnostic evaluation of liver diseases. Radiology 92:313-322, 1969

53. Lorenzo GA, Beal JM: Recent diagnostic advances in obstructive jaundice. Surg Clin M Am 51:211-221, 1971

54. Rösch J, Lakin PC, Antonovic R, et al: Transjugular approach to liver biopsy and transhepatic cholangiography. N Engl J Med 289:227-231, 1973

55. Cotton PB: Progress report—Cannulation of the papilla of Vater by endoscopy and retrograde cholangiopancreatography (ERCP). Gut 13:1014-1025, 1972

56. Safrany L, Tari L, Barna L, et al: Endoscopic retrograde cholangiography—Experience of 168 examinations. Gastroent Endosc 19:163-168, 1973

57. Whittaker R, Gibbs D: The collection of pancreatic fluid for cytodiagnosis using a duodenoscope. Gut 15:305-307, 1974

58. Sharma MP, Gregg JS, McCabe RP: Carcinoembryonic antigen (CEA_1)—Bile activity in pancreatic juice of patients with pancreatic carcinoma and pancreatitis (abstract). Gastroenterology 66:776, 1974

59. Ammon RW, Deykle P, Butikofer E: Fatal necrotizing pancreatitis after peroral cholangiopancreatography. Gastroenterology 64:320-323, 1973

60. Antonovic R, Rösch J: Arteriography and heparinization—A control study. Radiology (in press)

61. Reuter SR, Redman HC: Gastrointestinal Angiography. Philadelphia, W B Saunders Co, 1972

62. Rosch J, Grollman JH, Steckel RJ: Arteriography in the diagnosis of gallbladder disease. Radiology 92:1485-1491, 1969

63. DuPriest RW Jr, Haines JE, Rosch J, et al: A comparison of scintiscans and arteriograms for identifying metastatic intrahepatic tumors. Surg Gyn Obst 136:705-710, 1973

64. Bookstein JJ, Reuter SR, Martel W: Angiographic evaluation of pancreatic carcinoma. Radiology 93:757-764, 1969

65. Tylen U: Accuracy of angiography in the diagnosis of carcinoma of the pancreas. Acta Radiologica Diagn 14:449-466, 1973

66. Rourke JA, Bosniak MA, Ferris EJ: Hepatic angiography in "alcoholic hepatitis." Radiology 91:290-296, 1968

67. Pollard JJ, Nebesar RA, Mattaso LF: Angiographic diagnosis of benign disease of the liver. Radiology 86:276-283, 1966

68. Deutsch V: Cholecysto-angiography. Am J Roentgen 101: 608-616, 1967

69. Kaude J, Rian R: Cholangiocarcinoma. Radiology 100:573-580, 1971

70. Hanafee WN, Weiner M: Transjugular percutaneous cholangiography. Radiology 88:35-39, 1967

71. Viamonte M Jr, Warren WD, Fomon JJ: Liver panangiography in the assessment of portal hypertension in liver cirrhosis. Radiol Clin N Am 8:147-167, 1970